## PATENT SPECIFICATION

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## (54) REMOVING METALS FROM SULPHIDE ORES

We, CYPRUS METALLURGICAL PROCESSES CORPORATION, a Corporation organised and existing under the laws of the State of Colorado, United States of America, of 555 South Flower Stree, Los Angeles, California, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to processes for recovering metals from sulphide ores

containing lead, silver and zinc sulphides.

It has been proposed hitherto to convert metallic sulphides into chlorides in metal recovery processes. For example metal sulphide concentrates can be chlorinated with ferric chloride and chlorine gas in aqueous sodium chloride or

calcium chloride, (see U.S. Patent 1,736,659).

It has also been proposed hitherto ("The Dry Chlorination of Complex Ores" by Ionides in Mining and Scientific Press, Volume 112, May 27, 1916), to chlorinate dry concentrates of metal sulphides containing lead, zinc and silver sulphides, using chlorine gas. A final chlorination is effected in a roasting step in the presence of air, ferric chloride formed in the chlorination step being decomposed to produce chlorine which completes the chlorination of the metal sulphides. This latter hitherto proposed process can be used for the production of zinc chloride, and it is not a pollution-free process as sulphur dioxide is produced in the roasting step and it is released into the atmosphere. Furthermore, when the chlorination product is treated with sodium chloride to solubilize the metal chlorides, an undesirable build-up of impurities, particularly zinc chloride, occurs in the brine leach solution. This adversely affects the ability of the solution after a period of time to solubilize silver and lead chlorides from the chlorinated ore

According to one aspect of the present invention there is provided a process for recovering metal values from a sulphide ore concentrate containing lead, silver and zinc sulphides, the process comprising the steps of:

(a) chlorinating the concentrate to convert the metal sulphides into metal chlorides and to convert sulphide sulphur into elemental sulphur;

(b) leaching the non gaseous product from step (a) with aqueous sodium chloride to dissolve lead and silver chlorides therein therby to enable separation of these chlorides from insoluble solids;

(c) cooling the sodium chloride leach solution to precipitate substantially all of the lead chloride therein followed by separating the precipitated lead chloride from the leach solution;

(d) recovering silver from the lead chloride-depleted leach solution obtained in step (c);

(e) removing a portion of the solution produced in step (d) and passing the remainder of the solution to the leach solution of step (b);

(f) removing substantially all of the zinc and other impurities from the

portion of solution removed in step (e);
(g) part electrolysing the removed portion of the solution to produce chlorine gas while leaving a weakened sodium chloride solution;

(h) passing the remaining electrolyte solution to step (b); and

(i) passing chlorine gas produce in step (g) to step (a). According to another aspect of the present invention there is provided a

steps of:  (a) dry chlorinating the pulverized concentrate with chlorine ge temperature of from 50 to 150°C to convert the sulphides into chlorivolatilize antimony chloride produced, and to convert the sulphide sulphides into chlorivolatilize antimony chloride produced, and to convert the sulphide sulphides lemental sulphur;  (b) leaching the non gaseous product from step (a) at a temperature 80 to 100°C with an aqueous solution containing from 250 to 300 grams, of the convertion of the conver	2	1,510,127	
(a) dry chlorinating the pulverized concentrate with chlorine gs temperature of from 50 to 150°C to convert the sulphides into chlorivolatilize antimony chloride produced, and to convert the sulphide sulphe elemental sulphur;  (b) leaching the non gaseous product from step (a) at a temperature so to 100°C with an aqueous solution containing from 250 to 300 grams. Sodium chloride to dissolve lead chloride and silver chloride, and to extrachlorides from the remaining solids;  (c) cooling the sodium chloride leach solution from step (b) to about precipitate substantially all of the lead chloride and separating the precipate chlorine gas and lead;  (c) passing the chlorine gas from step (c) and electrolyzing the fuser produce chlorine gas and lead;  (e) passing the chlorine gas from step (d) to step (a);  (f) recovering silver from the lead chloride-depleted leach semaining from step (c) by cementation with metallic iron;  (g) removing from 5 to 15% by weight of the silver and lead-deplete solution from step (f), and passing the remainder of the depleted leach softhe leach solution of step (b);  (h) removing any lead and silver remaining in the removed portion metal-depleted solution by iron cementation;  (i) part electrolysing sodium chloride in said removed portion of the depleted solution to produce chlorine gas while leaving a weakened chloride solution;  (k) passing the chlorine gas from step (j) to step (a);  (l) carbonating sodium hydroxide formed in step (j) to produce carbonate and passing the sodium carbonate to step (j); and  (m) passing the remaining sodium chlorides solution from step (j) to some chlorides of the metals and fiberate elemental sulphur, leaching the chlorides of the metals and fiberate elemental sulphur, leaching the chlorides of the metals and fiberate elemental sulphur, leaching the colorides of the metals and fiberate elemental sulphur, leaching the colorides of the metals and fiberate elemental sulphur, leaching the colorides of the metals and fiberate elemental sulphur, leaching the		process for recovering metal values from a galena/tetrahedrite ore concentrate containing lead, silver, antimony and zinc sulphides, the process comprising the	
temperature of from \$0 to 150°C to convert the sulphides sulph elemental sulphur;  (b) leaching the non gaseous product from step (a) at a temperature 80 to 100°C with an aqueous solution containing from 250 to 300 grams, sodium chloride to dissolve lead chloride and silver chloride, and to extract chlorides from the remaining solids;  (c) cooling the sodium chloride leach solution from step (b) to about precipitate substantially all of the lead chloride and separating the preclead chloride therefrom;  (d) fusing the lead chloride from step (c) and electrolyzing the fuseor produce chlorine gas and lead;  (e) passing the chlorine gas from step (d) to step (a);  (f) recovering silver from the lead chloride-depleted leach solution from step (c) by cementation with metallic iron;  (g) removing from 5 to 15% by weight of the silver and lead-deplete solution from step (f), and passing the remaining in the removed portion metal-depleted solution by iron cementation;  (h) removing any lead and silver remaining in the removed portion metal-depleted solution by iron cementation;  (i) predictating zinc and other impurities from said removed portion metal-depleted solution using sodium carbonate;  (j) part electrolysing sodium chloride in said removed portion of the depleted solution;  (k) passing the chlorine gas from step (j) to step (a);  (l) carbonating sodium hydroxide formed in step (j) to produce carbonate and passing the sodium carbonate to step (j); and  (m) passing the remaining sodium chloride solution from step (j) to produce carbonate and passing the sodium carbonate to step (j); and  (m) passing the process comprising chlorinating the sulphide or to produce chlorides of the metals and liberate elemental sulphur, leaching the chlorides of the metals and liberate elemental sulphur, leaching the chloride depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead and silver-depleted leach solution, and belated leach solution, and belated leach solution, and belated leach soluti		steps of:	
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(f) recovering silver from the lead chloride-depleted leach s remaining from step (c) by cementation with metallic iron;  (g) removing from 5 to 15% by weight of the silver and lead-deplete solution from step (f), and passing the remainder of the depleted leach soluther the leach solution of step (b);  (h) removing any lead and silver remaining in the removed portion metal-depleted solution by iron cementation;  (i) precipitating zinc and other impurities from said removed portion metal-depleted solution using sodium carbonate;  (j) part electrolysing sodium chloride in said removed portion of the depleted solution to produce chlorine gas while leaving a weakened chloride solution;  (k) passing the chlorine gas from step (j) to step (a);  (k) passing the chlorine gas from step (j) to step (i); and  (m) passing the remaining sodium chloride solution from step (j) to say According to a further aspect of the present invention there is pro process for recovering metals from an ore containing lead, silver, as sulphides, the process comprising chlorinating the sulphide ore to produce chlorides of the metals and liberate elemental sulphur, leaching the chloric sodium chloride to remove lead and silver chlorides, separating lead chlorisilver chloride by cooling the leach solution, recovering silver by cement the lead chloride-depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead and depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is proprocess for recovering metals from a sulphide ore containing at least the stop lead, silver, and zinc, the process comprising converting the sulphic chlorides by chlorination, leaching the chlorides into sodium chloride to produce chlorine, the chlorides and silver-depleted solution to the leaching step, electrolyzing the zinc-depleted solution consodium chloride to produce chlorine		(a) passing the chlorine gas from sten (d) to sten (a):	
remaining from step (c) by cementation with metallic iron;  (g) removing from 5 to 15% by weight of the silver and lead-deplete solution from step (f), and passing the remainder of the depleted leach solution from step (b);  (h) removing any lead and silver remaining in the removed portion metal-depleted solution by iron cementation;  (i) precipitating zinc and other impurities from said removed portion metal-depleted solution using sodium carbonate;  (j) part electrolysing sodium chloride in said removed portion of the depleted solution to produce chlorine gas while leaving a weakened chloride solution;  (k) passing the chlorine gas from step (j) to step (a);  (l) carbonating sodium hydroxide formed in step (j) to produce carbonate and passing the sodium hydroxide formed in step (j) to produce carbonate and passing the sodium carbonate to step (j); and  (m) passing the remaining sodium chloride solution from step (j) to sing According to a further aspect of the present invention there is proposes for recovering metals from an ore containing lead, silver, as sulphides, the process comprising chlorinating the sulphide ore to produce chlorides of the metals and liberate elemental sulphur, leaching the chloride sodium chloride to remove lead and silver-chlorides, separating lead chlorides in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead and depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is process for recovering metals from a sulphide ore containing at least the soft lead, silver, and zinc, the process comprising converting the sulphic chlorides by chlorination, leaching the chlorides into sodium chloride solution to the leaching step, lectrolyzing the zinc-depleted solution consolium chloride to produce chlorine, the chlorin		(f) recovering silver from the lead chloride-depleted leach solution	
g) removing from 5 to 15% by weight of the silver and lead-depleted solution from step (f), and passing the remainder of the depleted leach solution the leach solution by iron cementation;  (i) precipitating zinc and other impurities from said removed portion metal-depleted solution using sodium carbonate;  (j) part electrolysing sodium chloride in said removed portion of the depleted solution to produce chlorine gas while leaving a weakened chloride solution;  (k) passing the chlorine gas from step (j) to step (a);  (l) carbonating sodium hydroxide formed in step (j) to produce carbonate and passing the sodium carbonate to step (i); and  (m) passing the remaining sodium cloride solution from step (j) to step and the process for recovering metals from an ore containing lead, silver, as sulphides, the process comprising chlorinating the sulphide ore to prod chlorides of the metals and liberate elemental sulphur, leaching the chloric sodium chloride to remove lead and silver chlorides, separating lead chlorisiver chloride by cooling the leach solution, recovering silver by cement the lead chloride-depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead and depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is pro process for recovering metals from a sulphide ore containing at least the stof lead, silver, and zinc, the process comprising converting the sulphic chlorides by chlorination, leaching the chlorides into sodium chloride s removing zinc from a portion of the resulting lead and silver-depleted solution to recovering of lead, recovering silver from the leach solution by ceme removing zinc from a portion of the resulting lead and silver-depleted solution consolium chloride to produce chlorine, the chlorination step being effected dry chlorine gas to convert the metal sulphides to chlorides and sulphide to el		remaining from step (c) by cementation with metallic iron:	
solution from step (f), and passing the remainder of the depleted leach solit the leach solution of step (b);  (h) removing any lead and silver remaining in the removed portion metal-depleted solution by iron cementation;  (i) precipitating zinc and other impurities from said removed portion metal-depleted solution using sodium carbonate;  (j) part electrolysing sodium chloride in said removed portion of the depleted solution to produce chlorine gas while leaving a weakened chloride solution;  (k) passing the chlorine gas from step (j) to step (a);  (l) carbonating sodium hydroxide formed in step (j) to produce carbonate and passing the sodium carbonate to step (i); and  (m) passing the remaining sodium chloride solution from step (j) to six According to a further aspect of the present invention there is pro process for recovering metals from an ore containing lead, silver, as sulphides, the process comprising chlorinating the sulphide ore to product chlorides of the metals and liberate elemental sulphur, leaching the chloric sodium chloride to remove lead and silver chlorides, separating lead chlorisilver chloride by cooling the leach solution, recovering silver by cement the lead chloride-depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead and depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is proposes for recovering metals from a sulphide ore containing at least the solution yet carbonate, recovering silver from the leach solution by ceme removing lead chloride from the leach solution by crystallization recovering of lead, recovering silver from the leach solution by ceme removing zinc from a portion of the resulting lead and silver-depleted solution consolution to the leaching step, electrolyzing the zinc-depleted solution consolution to the leaching step, electrolyzing the zinc-depleted solution con	20	(g) removing from 5 to 15% by weight of the silver and lead-depleted leach	20
the leach solution of step (b);  (h) removing any lead and silver remaining in the removed portion metal-depleted solution by iron cementation;  (i) precipitating zinc and other impurities from said removed portion metal-depleted solution using sodium carbonate;  (j) part electrolysing sodium chloride in said removed portion of the depleted solution;  (k) passing the chlorine gas from step (j) to step (a);  (l) carbonating sodium hydroxide formed in step (j) to produce carbonate and passing the sodium carbonate to step (i); and  (m) passing the remaining sodium chloride solution from step (j) to side (a);  According to a further aspect of the present invention there is proprocess for recovering metals from an ore containing lead, silver, as sulphides, the process comprising chlorinating the sulphide ore to produce chlorides of the metals and liberate elemental sulphur, leaching the chloric sodium chloride to remove lead and silver chlorides, separating lead chloriosilver chloride by cooling the leach solution, recovering silver by cement the lead chloride-depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead and depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is proprocess for recovering metals from a sulphide ore containing at least the store is removing lead chloride from the leach solution by crystallization recovering of lead, recovering silver from the leach solution by crystallization recovering of lead, recovering silver from the leach solution by creme removing zinc from a portion of the resulting lead and silver-depleted solution to the leaching step, electrolyzing the zinc-depleted solution consolum chloride to produce chlorine, the chlorination step being effected try chlorine gas to convert the metal sulphides to chlorides and sulphide to elemental sulphur.  Using a process employing the presen	20	solution from step (f), and passing the remainder of the depleted leach solution to	
(h) removing any lead and silver remaining in the removed portion metal-depleted solution by iron cementation;  (i) precipitating zinc and other impurities from said removed portion metal-depleted solution using sodium carbonate;  (j) part electrolysing sodium chloride in said removed portion of the depleted solution to produce chlorine gas while leaving a weakened chloride solution;  (k) passing the chlorine gas from step (j) to step (a);  (l) carbonating sodium hydroxide formed in step (j) to produce carbonate and passing the sodium carbonate to step (i); and  (m) passing the remaining sodium chloride solution from step (j) to stop (a);  According to a further aspect of the present invention there is produce to the product of the metals and liberate elemental sulphur, leaching the chlorides of the metals and liberate elemental sulphur, leaching the chlorid solium chloride to remove lead and silver chlorides, separating lead chlorisilver chloride by cooling the leach solution, recovering silver by cement the lead chloride-depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead and depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is process for recovering metals from a sulphide ore containing at least the stop lead, silver, and zinc, the process comprising converting the sulphic chlorides by chlorination, leaching the chlorides into sodium chloride s removing lead chloride from the leach solution by ceme removing zinc from a portion of the resulting lead and silver-depleted solution containing lead, silver and zinc, the process comprising converting the sulphide to elemental sulphur.  Using a process employing the present invention, sulphide ore concurating lead, silver and zinc sulphides can be treated in particular to silver and lead. The recovery of metals from their chlorides resulting for chlorinety, in		the leach solution of step (b):	
metal-depleted solution by iron cementation;  (i) precipitating zinc and other impurities from said removed portion metal-depleted solution using sodium carbonate;  (j) part electrolysing sodium chloride in said removed portion of the depleted solution to produce chlorine gas while leaving a weakened chloride solution;  (k) passing the chlorine gas from step (j) to step (a);  (l) carbonating sodium hydroxide formed in step (j) to produce carbonate and passing the sodium carbonate to step (j); and  (m) passing the remaining sodium chloride solution from step (j) to si According to a further aspect of the present invention there is proprocess for recovering metals from an ore containing lead, silver, as sulphides, the process comprising chlorinating the sulphide ore to prodict chlorides of the metals and liberate elemental sulphur, leaching the chloric sodium chloride to remove lead and silver chlorides, separating lead chloric silver chloride by cooling the leach solution, recovering silver by cement the lead chloride-depleted solution, reducing the concentration of zince an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead an depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is proprocess for recovering metals from a sulphide ore containing at least the stop lead, silver, and zinc, the process comprising converting the sulphide sermoving lead chloride from the leach solution by crystallization recovering of lead, recovering silver from the leach solution by crystallization recovering of lead, recovering silver from the leach solution by crystallization recovering gas to convert the metal sulphides to chlorides and sulphide to elemental sulphur.  Using a process employing the present invention, sulphide ore containing lead, silver and zinc sulphides can be treated in particular to silver and lead. The recovery of metals from their chlorides resulting for chlori		(h) removing any lead and silver remaining in the removed portion of the	
metal-depleted solution using sodium carbonate; (j) part electrolysing sodium chloride in said removed portion of the depleted solution to produce chlorine gas while leaving a weakened chloride solution; (k) passing the chlorine gas from step (j) to step (a); (l) carbonating sodium hydroxide formed in step (j) to produce carbonate and passing the sodium carbonate to step (i); and (m) passing the remaining sodium chloride solution from step (j) to significant to a further aspect of the present invention there is proprocess for recovering metals from an ore containing lead, silver, as sulphides, the process comprising chlorinating the sulphide ore to product chlorides of the metals and liberate elemental sulphur, leaching the chloric sodium chloride to remove lead and silver chlorides, separating lead chloric silver chloride by cooling the leach solution, recovering silver by cement the lead chloride-depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead and depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is proposes for recovering metals from a sulphide ore containing at least the step of lead, silver, and zinc, the process comprising converting the sulphic chlorides by chlorination, leaching the chlorides into sodium chloride sermoving lead chloride from the leach solution by crystallization recovering of lead, recovering silver from the leach solution by ceme to solution to the leaching step, electrolyzing the zinc-depleted solution consolution to the leaching step, electrolyzing the zinc-depleted solution consolution to the leaching step, electrolyzing the zinc-depleted solution consolution to the leaching step, electrolyzing the zinc-depleted solution consolution to a process employing the present invention, sulphide ore concontaining lead, silver and zinc sulphides can be treated in particular to silver		metal-depleted solution by iron cementation:	
(j) part electrolysing sodium chloride in said removed portion of the depleted solution;  (k) passing the chlorine gas from step (j) to step (a);  (l) carbonating sodium hydroxide formed in step (j) to produce carbonate and passing the sodium carbonate to step (j); and  (m) passing the remaining sodium chloride solution from step (j) to step (a);  According to a further aspect of the present invention there is pro process for recovering metals from an ore containing lead, silver, as sulphides, the process comprising chlorinating the sulphide ore to produce chlorides of the metals and liberate elemental sulphur, leaching the chloric sodium chloride to remove lead and silver chlorides, separating lead chloric silver chloride by cooling the leach solution, recovering silver by cement the lead chloride-depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead an depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is progress for recovering metals from a sulphide ore containing at least the stop is solution to the leaching step.  According to a yet further aspect of the present invention there is progress for recovering metals from a sulphide ore containing at least the stop is sulphiced. The process for recovering metals from a sulphide ore containing at least the stop is sulphiced. The process for recovering silver from the leach solution by ceme removing lead chloride from the leach solution by crystallization recovering of lead, recovering silver from the leach solution by ceme removing zinc from a portion of the resulting lead and silver-depleted solution to the leaching step, electrolyzing the zinc-depleted solution consolium chloride to produce chlorine, the chlorination step being effected solution to the leaching step, electrolyzing the zinc-depleted solution consolium chloride to produce chlorides and to vola	25	(i) precipitating zinc and other impurities from said removed portion of the	25
depleted solution to produce chlorine gas while leaving a weakened chloride solution;  (k) passing the chlorine gas from step (j) to step (a); (l) carbonating sodium hydroxide formed in step (j) to produce carbonate and passing the sodium carbonate to step (j); and (m) passing the remaining sodium chloride solution from step (j) to step (carbonate and passing the sodium chloride solution from step (j) to step (carbonate and passing the remaining sodium chloride solution from step (j) to step (carbonate and passing the remaining sodium chloride solution to the present invention there is proposed the process for recovering metals from an ore containing lead, silver, as sulphides, the process comprising chlorinating the sulphide ore to product chlorides of the metals and liberate elemental sulphur, leaching the chloric sodium chloride to remove lead and silver chlorides, separating lead chloric sodium chloride depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead and depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is proprocess for recovering metals from a sulphide ore containing at least the stop is solution to the leach solution by crystallization recovering of lead, recovering silver from the leach solution by crystallization recovering of lead, recovering silver from the leach solution by ceme removing zinc from a portion of the resulting lead and silver-depleted solution to the leaching step, electrolyzing the zinc-depleted solution consolution to the leaching step, electrolyzing the zinc-depleted solution consolution to the leaching step, electrolyzing the zinc-depleted solution consolution to the leaching step, electrolyzing the zinc-depleted solution consolution and sulphide to elemental sulphur.  Using a process employing the present invention, sulphide ore concontaining lead, silver and zinc sulphid		metal-depleted solution using sodium carbonate;	
chloride solution;  (k) passing the chlorine gas from step (j) to step (a);  (l) carbonating sodium hydroxide formed in step (j) to produce carbonate and passing the sodium carbonate to step (i); and  (m) passing the remaining sodium chloride solution from step (j) to si According to a further aspect of the present invention there is pro process for recovering metals from an ore containing lead, silver, as sulphides, the process comprising chlorinating the sulphide ore to prod chlorides of the metals and liberate elemental sulphur, leaching the chloric sodium chloride to remove lead and silver chlorides, separating lead chlorisilver chloride by cooling the leach solution, recovering silver by cement the lead chloride-depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead an depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is proposes for recovering metals from a sulphide ore containing at least the soil lead, silver, and zinc, the process comprising converting the sulphic chlorides by chlorination, leaching the chlorides into sodium chloride removing lead chloride from the leach solution by crystallization recovering of lead, recovering silver from the leach solution by ceme removing zinc from a portion of the resulting lead and silver-depleted solutinc consodium chloride to produce chlorine, the chlorination step being effected dry chlorine gas to convert the metal sulphides to chlorides and sulphide to elemental sulphur.  Using a process employing the present invention, sulphide ore concentaining lead, silver and zinc sulphides can be treated in particular to silver and lead. The recovery of metals from their chlorides resulting finchlorides, formed in the chlorination step, As an alternative to wet chlorin the sulphides, dry chlorination can be effected using dry chlorine gas, with to convert the sulphide		(j) part electrolysing sodium chloride in said removed portion of the metal-	
(k) passing the chlorine gas from step (j) to step (a); (l) carbonating sodium hydroxide formed in step (j) to produce carbonate and passing the sodium carbonate to step (j); and (m) passing the remaining sodium chloride solution from step (j) to stand (m) passing the remaining sodium chloride solution from step (j) to stand According to a further aspect of the present invention there is proposes for recovering metals from an ore containing lead, silver, as sulphides, the process comprising chlorinating the sulphide ore to produce chlorides of the metals and liberate elemental sulphur, leaching the chloride sodium chloride to remove lead and silver chlorides, separating lead chlorisive chloride by cooling the leach solution, recovering silver by cement the lead chloride-depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead an depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is proposes for recovering metals from a sulphide ore containing at least the standard silver, and zinc, the process comprising converting the sulphide chlorides by chlorination, leaching the chlorides into sodium chloride semoving lead chloride from the leach solution by crystallization recovering of lead, recovering silver from the leach solution by ceme removing zinc from a portion of the resulting lead and silver-depleted solution to the leaching step, electrolyzing the zinc-depleted solution consodium chloride to produce chlorine, the chlorination step being effected dry chlorine gas to convert the metal sulphides to chlorides and sulphide to elemental sulphur.  Using a process employing the present invention, sulphide ore concontaining lead, silver and zinc sulphides can be treated in particular to silver and lead. The recovery of metals from their chlorides resulting fine chlorides, in the sodium chloride leach solution used to so		depleted solution to produce chlorine gas while leaving a weakened sodium	
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carbonate and passing the sodium carbonate to step (i); and  (m) passing the remaining sodium chloride solution from step (j) to standard (m) passing the remaining sodium chloride solution from step (j) to standard (m) process for recovering metals from an ore containing lead, silver, as sulphides, the process comprising chlorinating the sulphide ore to produce thorides of the metals and liberate elemental sulphur, leaching the chlorid sodium chloride to remove lead and silver chlorides, separating lead chloridiver chloride by cooling the leach solution, recovering silver by cement the lead chloride-depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead an depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is proposes for recovering metals from a sulphide ore containing at least the standard silver, and zinc, the process comprising converting the sulphic chlorides by chlorination, leaching the chlorides into sodium chloride seremoving lead chloride from the leach solution by crystallization recovering of lead, recovering silver from the leach solution by ceme removing zinc from a portion of the resulting lead and silver-depleted solution to the leaching step, electrolyzing the zinc-depleted solution consolium chloride to produce chlorine, the chlorination step being effected dry chlorine gas to convert the metal sulphides to chlorides and sulphide to elemental sulphur.  Using a process employing the present invention, sulphide ore concontaining lead, silver and zinc sulphides can be treated in particular to silver and lead. The recovery of metals from their chlorides resulting for chlorination step is effected so as to prevent the build-up of impurities, in zinc chloride, in the sodium chloride leach solution used to solubilize the chlorides formed in the chlorination can be effected using dry chlorine gas, wi	30	(k) passing the chlorine gas from step (j) to step (a);	30
(m) passing the remaining sodium chloride solution from step (j) to si According to a further aspect of the present invention there is pro process for recovering metals from an ore containing lead, silver, as sulphides, the process comprising chlorinating the sulphide ore to prod chlorides of the metals and liberate elemental sulphur, leaching the chloric sodium chloride to remove lead and silver chlorides, separating lead chlori silver chloride by cooling the leach solution, recovering silver by cement the lead chloride-depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead an depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is process for recovering metals from a sulphide ore containing at least the standard silver, and zinc, the process comprising converting the sulphic chlorides by chlorination, leaching the chlorides into sodium chlorides removing lead chloride from the leach solution by crystallization recovering of lead, recovering silver from the leach solution by ceme removing zinc from a portion of the resulting lead and silver-depleted solution to the leaching step, electrolyzing the zinc-depleted solution consolium chloride to produce chlorine, the chlorination step being effected dry chlorine gas to convert the metal sulphides to chlorides and sulphide to elemental sulphur.  Using a process employing the present invention, sulphide ore concontaining lead, silver and zinc sulphides can be treated in particular to silver and lead. The recovery of metals from their chlorides resulting from chloride, in the sodium chloride leach solution used to solubilize the chlorides formed in the chlorination step. As an alternative to wet chlorin the sulphides, dry chlorination can be effected using dry chlorine gas, with to convert the sulphides to chlorides and to volatilize the chlorides of area antimony, if		(1) carbonating sodium hydroxide formed in step (1) to produce sodium	
According to a further aspect of the present invention there is pro process for recovering metals from an ore containing lead, silver, as sulphides, the process comprising chlorinating the sulphide ore to produce chlorides of the metals and liberate elemental sulphur, leaching the chloric sodium chloride to remove lead and silver chlorides, separating lead chloric silver chloride by cooling the leach solution, recovering silver by cement the lead chloride-depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead an depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is proposes for recovering metals from a sulphide ore containing at least the sulphide chlorides by chlorination, leaching the chlorides into sodium chlorides removing lead chloride from the leach solution by crystallization recovering of lead, recovering silver from the leach solution by ceme removing zinc from a portion of the resulting lead and silver-depleted solution to the leaching step, electrolyzing the zinc-depleted solution consolium chloride to produce chlorine, the chlorination step being effected dry chlorine gas to convert the metal sulphides to chlorides and sulphide to elemental sulphur.  Using a process employing the present invention, sulphide ore concontaining lead, silver and zinc sulphides can be treated in particular to silver and lead. The recovery of metals from their chlorides resulting for chloride, in the sodium chloride leach solution used to solubilize the chlorides formed in the chlorination step. As an alternative to wet chlorin the sulphides, dry chlorination can be effected using dry chlorine gas, with to convert the sulphides to chlorides and to volatilize the chlorides of area antimony, if these metals are present. Dry chlorination has been found part		carbonate and passing the sodium carbonate to step (1), and	
sulphides, the process comprising chlorinating the sulphide ore to prod chlorides of the metals and liberate elemental sulphur, leaching the chloric sodium chloride to remove lead and silver chlorides, separating lead chlori silver chloride by cooling the leach solution, recovering silver by cement the lead chloride-depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead an depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is pro process for recovering metals from a sulphide ore containing at least the su of lead, silver, and zinc, the process comprising converting the sulphic chlorides by chlorination, leaching the chlorides into sodium chloride s removing lead chloride from the leach solution by crystallization recovering of lead, recovering silver from the leach solution by ceme removing zinc from a portion of the resulting lead and silver-depleted solution cording to the leaching step, electrolyzing the zinc-depleted solution con sodium chloride to produce chlorine, the chlorination step being effect dry chlorine gas to convert the metal sulphides to chlorides and sulphide to elemental sulphur.  Using a process employing the present invention, sulphide ore conc containing lead, silver and zinc sulphides can be treated in particular to silver and lead. The recovery of metals from their chlorides resulting for chloride, in the sodium chloride leach solution used to solubilize th chlorides formed in the chlorination step. As an alternative to wet chlorin the sulphides, dry chlorination can be effected using dry chlorine gas, with to convert the sulphides to chlorides and to volatilize the chlorides of area antimony, if these metals are present. Dry chlorination has been found part		According to a further aspect of the present invention there is provided a	
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chlorides of the metals and liberate elemental sulphur, leaching the chloric sodium chloride to remove lead and silver chlorides, separating lead chlori silver chloride by cooling the leach solution, recovering silver by cement the lead chloride-depleted solution, reducing the concentration of zinc an impurities in a portion of the lead and silver-depleted leach solution, and both the zinc-depleted and non zinc-depleted portions of the lead an depleted leach solution to the leaching step.  According to a yet further aspect of the present invention there is process for recovering metals from a sulphide ore containing at least the sulphic chlorides by chlorination, leaching the chlorides into sodium chloride s removing lead chloride from the leach solution by crystallization recovering of lead, recovering silver from the leach solution by ceme removing zinc from a portion of the resulting lead and silver-depleted solution to the leaching step, electrolyzing the zinc-depleted solution consolium chloride to produce chlorine, the chlorination step being effected dry chlorine gas to convert the metal sulphides to chlorides and sulphide to elemental sulphur.  Using a process employing the present invention, sulphide ore concacontaining lead, silver and zinc sulphides can be treated in particular to silver and lead. The recovery of metals from their chlorides resulting for chlorination step is effected so as to prevent the build-up of impurities, in zinc chloride, in the sodium chloride leach solution used to solubilize the chlorides formed in the chlorination step. As an alternative to wet chlorin the sulphides, dry chlorination can be effected using dry chlorine gas, with to convert the sulphides to chlorides and to volatilize the chlorides of area antimony, if these metals are present. Dry chlorination has been found part	33	sulphides the process comprising chlorinating the sulphide ore to produce the	
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solution to the leaching step, electrolyzing the zinc-depleted solution consodium chloride to produce chlorine, the chlorination step being effected dry chlorine gas to convert the metal sulphides to chlorides and sulphide to elemental sulphur.  Using a process employing the present invention, sulphide ore concactontaining lead, silver and zinc sulphides can be treated in particular to silver and lead. The recovery of metals from their chlorides resulting for chlorination step is effected so as to prevent the build-up of impurities, in zinc chloride, in the sodium chloride leach solution used to solubilize the chlorides formed in the chlorination step. As an alternative to wet chloring the sulphides, dry chlorination can be effected using dry chlorine gas, with to convert the sulphides to chlorides and to volatilize the chlorides of arse antimony, if these metals are present. Dry chlorination has been found part	50	zinc carbonate, returning the untreated portion of the lead and silver-depleted	
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to convert the sulphides to chlorides and to volatilize the chlorides of arse antimony, if these metals are present. Dry chlorination has been found part		the culphides dry chlorination can be effected using dry chlorine ass with heating	
antimony, if these metals are present. Dry chlorination has been found part		to convert the sulphides to chlorides and to volatilize the chlorides of arsenic and	
		antimony, if these metals are present. Dry chlorination has been found particularly	
	65	effective with sulphides of the tetrahedrite-tennantite series either alone or	65
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	•		
3	1,510	5,127	3
5	leached into warm sodium chloride s solution. The metals, lead and silver, recovered from the separated aqueous cooling, and lead can be recovered from with the chlorine produced being pass removed from the lead chloride-deplet	des by any method, metal chlorides are olution and separated from the resulting which are of principal interest are then chlorides. Lead chloride is crystallized by a the lead chloride by fused salt electrolysis ed to the chlorination step. Silver can be ed solution by cementation. The resulting	5
10	passed to the sodium chloride brine le depleted solution, after removal of lead is preferably neutralized with sodium of impurities as carbonates. Part electron	n which a portion has been separated, is each. The separated portion of the metaland silver therefrom by iron cementation, carbonate to remove zinc and other metalolysis of the resulting solution produces hlorination step while some of the weak	10
15	chloride brine leach to prevent the built process is being effected continuously.	is concentrated and passed to the sodium d-up of zinc and other impurities when the Sodium hydroxide from the electrolysis is ulting sodium carbonate used in the	15
20	The recycling to the initial sodium the lead and silver chloride depleted removal of zinc and other metal impur from the brine leach solution at substan	chloride leaching solution of a portion of sodium chloride leach solution after the ities enables zinc chloride to be removed tially the same rate that it is added thereto in the brine leach solution, which would	20
25	retained in the system, so that substachloride in impurities or otherwise. An chlorine gas in the electrolysis and it	lead chloride. In addition, chlorine is ntially no chlorine leaves the system as chlorine which is removed is removed as spassed to the chlorination step without esent invention provides a substantially	25
30	released into the atmosphere. Substantia into elemental sulphur rather than su processes.	le or lead vapours or compounds being ally all of the sulphide sulphur is converted alphur dioxide, unlike pyrometallurgical	30
35	Figure 1 is a flow diagram showing process; and	nying diagrammatic drawings in which:— ng the various steps in the exemplified chlorination of a concentrate containing	35
40	read, silver, zitte alle antimony in a kill	hedrite concentrate having the following	40
	Silver	0.30— 0.35%	
	Lead	68 —70%	
	Antimony	0.80— 1.4%	
45	Sulphur (Total)	14 —17%	45
	Zinc	4 — 6%	

It is to be understood that other ores containing sulphides of lead, silver and zinc can be treated. The reactions occurring in the chlorination step are:

2 - 4%

Iron

50 
$$MS = Cl_2 \rightarrow MCl_2; (M = Pb, Zn, Cu, Fe, or Ag, etc.)$$

$$S_2 + Cl_2 \rightarrow S_2Cl_2$$

$$MS + S_2Cl_2 \rightarrow MCl_2 + 3/2 S_2$$

$$Sb_2S_2 + 5 Cl_2 \rightarrow 2 SbCl_5 + 3/2 S_2$$

		EXAMPL	E — Continued				
	Zone 2 Reaction:	Inert Gas	Nitrogen				
		Temperature	1i0—115°C				
		Time	1.5 Hr.				
5	Leach Conditions:	Pulp Density	50 g Chlorinate Leach Solution	ed Product per litre of	5		
		Leach Solution	290 g/l NaCl, pH	1.5			
		Temperature	95°C				
		Time	1.5 to 3 Hrs.				
10	Results:		Assay, %		10		
	-	PbS Concentrate 100 g	Chlorinated Product 121 g	Leached Residue 18.6 g			
	Ag	0.34	0.28	0.012			
15	Pb	70	58	0.12	15		
	Sb	1.2	0.41	0.098	•		
	Zn	4.5	3.7	16			
	Fe	2.7	2.3	7.9			
	Cu	0.94	0.80	0.18			
20	Cl	<0.1	23		20		
	% Sb Volatilized During (	Chlorination =	59				
	% Extracted During NaC	l Leach—Ag = !	99.3				
		Pb = 9	99.9				
		Sb .= 9	96				
25	Zn = 33						
		Fe = 4	17				
		Cu = 9	7				

These results show that more than 99 percent of the lead and silver present in the concentrate were converted into the chloride and extracted during the brine leach. In addition a substantial amount of the antimony was recovered. Substantially all of the sulphide sulphur was converted into elemental sulphur in the dry chlorination step. 30

1,510,127	
chlorine addition (200—280 kg. of chilofine per metric was 99% of the silver,	
the antimony were extracted. During the chlorination, antimony was volatilized, probably as SbCl <sub>3</sub> , and recovered from the waste gases. Arsenic, when present, can also be recovered in this manner. Substantially all of the sulphide sulphur in the	5
	10
chlorination is used, the flow sheet of Fig. 1 can be followed beyond the	
sodium chloride solution to solution lead and silver embraces, solution is chlorides which act as impurities. After start-up, the brine leach solution is supplemented with recycled sodium chloride in a continuous process, as shown.	15
approximately 40 grams per litre of lead, about 0.15 grams per litre of silver, 15 to 30 grams per litre of zinc, 15 to 30 grams per litre of ferrous iron, and lesser amounts of copper, antimony, calcium, magnesium, manganese, aluminium, etc. The brine leach step, irrespective of the concentrate being processed, is preferably	20
and the residue discarded or it desired processed to lead chloride is crystallized. The recovery of lead then follows. Solubilized lead chloride is crystallized from the sodium chloride leach solution by cooling from a temperature of 80 to 100°C to approximately 15 to 20°C. The resulting crystalline lead chloride is	25
in a fused salt cell to produce product lead, and chlorine gas which is recycled to	30
sodium chloride leach solution using metallic iron or lead to produce an impure	30
silver can be produced by reining this sponge. The lead and showled the solution produced, minus a portion thereof, is passed to brine leach as shown.  About 5 to 15% of the metal-depleted leach solution is treated to remove	35
and other impurities in the leach solution to be controlled, since zano salutions appreciably decreases the solubility of lead chloride in sodium chloride solutions. Accordingly, in order to dissolve large amounts of lead chloride, zinc chloride and accordingly in order to dissolve large amounts of lead chloride, zinc chloride and accordingly in order to dissolve large amounts of lead chloride, zinc chloride and accordingly in order to dissolve large amounts of lead chloride, zinc chloride and accordingly in order to dissolve large amounts of lead chloride, zinc chloride and accordingly in order to dissolve large amounts of lead chloride, zinc chloride and accordingly in order to dissolve large amounts of lead chloride.	40
Chlorination step.  Treatment of a portion of the metal-depleted solution also enables impurities  Treatment of a portion of the metal-depleted solution also enables impurities  The property of the metal-depleted solution also enables impurities  The property of the metal-depleted solution also enables impurities	45
loss of chlorine from the system. Chlorine is recovered as a gas and it is passed to the chlorination step, thereby avoiding loss of chlorine from the system.  As shown in Fig. 1 lead remaining in the portion of the metal-depleted solution is removed by cementation with metallic iron, and the resultant sponge lead is recycled to the silver cementation step. Any silver cemented out will also be recycled, and the lead concentration in solution in said portion of the solution	50
carbonate at a pH of about 8.5 and at a temperature of 50 to 80°C to precipitate zinc, iron and other metal impurities in a readily filterable form as carbonates.	55
system in removing zinc and other impurities.  The bleed solution, after solids removal, is part electrolysed to produce chlorine gas, hydrogen gas, sodium hydroxide, and a weak sodium chloride solution. The prior removal of zinc and other impurities from the solution greatly for illients the electrolysis as the electrolysis is almost physically impossible if zinc	60
and the other impurities are present in the electrolyte. The sodium hydroxide is carbonated to produce sodium carbonate which is recycled to the neutralization	65
	Using dry chlorination at a low temperature (80° to 115°C) with controlled chlorine addition (260—280 kg. of chlorine per metric ton of concentrate), followed by a sodium chloride leach at 90 to 95°C for an hour, 99% of the silver, 99.9% of the lead, 33%, of the zinc, 47% of the iron, 97% of the copper and 96% of the antimony were extracted. During the chlorination, antimony was volatilized, probably as SbCl,, and recovered from the waste gases. Arsenic, when present, can also be recovered in this manner. Substantially all of the sulphide sulphur in the metal sulphides was converted into elemental sulphur, unlike pyrometallurgical processes in which sulphur is released as the pollutant sulphur dioxide.  Referring to the flow sheet shown in Fig. 1, leaching described hereinbefore in the Example can be performed as follows. Irrespective of whether dry or wet chlorination is used, the flow sheet of Fig. 1 can be followed beyond the chlorination is used, the flow sheet of Fig. 1 can be followed beyond the chlorination step. The chlorinated product is leached in the brine leach with sodium chloride solution to solubilize lead and silver chlorides, and other metal chlorides which act as impurities. After start-up, the brine leach solution is supplemented with recycled sodium chloride in a continuous process, as shown. The leach solution for the tetrahedrite/galena concentrate during operation ordinarily contains from 260 to 280 grams per litre of sodium chloride, approximately 40 grams per litre of lead, about 0.15 grams per litre of solium chloride, approximately 40 grams per litre of sodium chloride, approximately 40 grams per litre of sodium chloride, and the residue discarded or if desired processed to recover elemental sulphur. The recovery of lead then follows. Solubilized lead chloride is crystallized from the sodium chloride leach solution by cooling from a temperature of 80 to 100°C. The leadh silure lead chloride is separated from the solution, for example by centrifuging, dried, and electrolyzed in a fused

7			1,516,12	27					7.
5	step. The chlorine gas is passed to the chlorination step, and the impurity-depleted sodium chloride solution is concentrated and passed to the leach step to prevent zinc build-up in the leach solution.  Processes employing the present invention can, of course, be performed either continuously or batch-wise.  Based on the results obtained using dry chlorination, a material balance for a typical commercially available lead sulphide concentrate (galena/tetrahedrite) is as follows:							<u>7.</u> 5	
10	ESTIMATED MATERIAL BALANCE FOR GALENA/TETRAHEDRITE.								10
			K	g/metric	Ton of	Concent	rate		
		Ag	Pb	Sb	Zn	Fe	Cu	S	
	Input PbS Concentrates	3.00	618	10.6	39.7	23.7	8.3	140	
15	Iron Powder					16			15
	Products	3.00	618	10.6	39.7	39.7	8.3	140	13
	Lead		611.4		•				
	Ag Sponge Sb Chloride	2.96	2.2	4.0		2.2	7.9		
20				6.2				~4	20
	Leach Residue	0.04	3.5	0.4	26.5	12.8	0.4	~ 136	
	Impurities Carbonates		0.9		13.2	24.7			
		3.00	618	10.6	39.7	39.7	8.3	140	
25	All the chlorine gas add This Table shows th without chlorine being le has to be added to a con example from mechanic	iat in those ost from	the sys	of the letem. Aft	er start-i	ip, virtu	ally no	chloride	25
30	while the invention has been illustrated in relation to treating a tetrahedrite/ galena concentrate containing lead, silver and zinc and the use of a dry chlorination procedure, it is not limited to treating this ore or to using dry chlorination. Thus dry or wet chlorination can be used on ores in general containing lead, zinc and silver. The flow sheet of Fig. 1 can then be followed beyond the chlorination step irrespective of						30		
35	beyond the chlorination Furthermore, metals can produced by wet chloring obtained in the Example	step, be restion of hereint	irrespectovered	tive of from the	of Fig. the me	thod of	en be i	followed rination.	35
40	l. A process for recontaining lead, silver and (a) chlorinating the chlorides and to convert (b) leaching the nor	WHAT WE CLAIM IS:  1. A process for recovering metal values from a sulphide ore concentrate containing lead, silver and zinc sulphides, the process comprising the steps of:  (a) chlorinating the concentrate to convert the metal sulphides into metal chlorides and to convert sulphide sulphur into elemental sulphur;  (b) leaching the non gaseous product from step (a) with aqueous sodium chloride to dissolve lead and silver chlorides the residue of the step of t							40
45	chloride to dissolve lead a of these chlorides from in (c) cooling the sodiu of the lead chloride therei from the leach solution;	soluble m chlor	solids;	es inere	in thereb	y to enal	ble sep	aration	45

	1,516,127	8
	(d) recovering silver from the lead chloride-depleted leach solution obtained	
•	in step (c); (e) removing a portion of the solution produced in step (d) and passing the	
	(e) removing a portion of the solution produced in the remainder of the solution to the leach solution of step (b); remainder of the solution to the leach solution of step (b);	5
•	(f) removing substantially an or the and	5
5	portion of solution removed in step (e);	
	(g) part electrolysing the lemove sodium chloride solution;	
	chlorine gas while leaving a weakened solution to step (b); and (h) passing the remaining electrolyte solution to step (a).	10
10	(i) passing chlorine gas produced in see a continuously	10
10	2 A process as claimed in claim 1, post 1 in which lead and silver	
	3. A process as claimed in claim 1 or claim 2, in which load and a second in the said portion removed in step (e) are removed by iron cementation remaining in the said portion removed in step (f)	
	hefore zinc is removed in stop (1/)	15
15	before zinc is removed in step (f).  4. A process as claimed in any of the preceding claims, in which zinc is removed  4. A process as claimed in any of the preceding claims, in which zinc is removed  4. A process as claimed in any of the preceding claims, in which zinc is removed  4. A process as claimed in any of the preceding claims, in which zinc is removed  4. A process as claimed in any of the preceding claims, in which zinc is removed  4. A process as claimed in any of the preceding claims, in which zinc is removed	
	from said portion in step (1) by noutrallers	
	codiling chioride and the date of the society hydroxide formed in the	
	electrolysis of the sodium emorids in the so	20
20	carbonate which is used to cheet the preceding claims, in which said portion	
	6 A process as claimed in any of the proceed to step (h).	
	7. A process as claimed in any figure action with dry chlorine gas.	
	concentrate is chlorinated in step (a) simplify the dry chlorination is effected at	2
25	X A process as claimed in claims,	
	Q A process as clatified in claim 7, v-	
	a temperature of 50 to 150 °C.	_
	10. A process as claimed in any of the preceding claims, in which the chloride leach solution contains from 250 to 300 grams per litre of sodium	3
30	chloride. chloride. dimension of the preceding claims, in which step (b) is	
	11. A process as claimed in any or the process	
	effected at a temperature of 80 to 100.	3
35	12. A process as claimed in any of the preceding claims, in which the precipitate lead chloride leach solution from step (c) is cooled to about 20°C to precipitate lead	Ĭ
55	chloride.  13. A process as claimed in any of the preceding claims, in which silver is	
	13. A process as claimed in any of the metallic iron. recovered in step (d) by cementation with metallic iron. recovered in step (d) by cementation with metallic iron.	
		4
40	concentrate is a galena/tetranedrite orc.	
	15. A process for recovering metal values from a galous concentrate containing lead, silver, antimony and zinc sulphides, the process	
	comprising the steps of comprising the steps of the pulverized concentrate with chlorine gas at a	
	(a) dry chlorinating the purveined the sulphides into chlorides, to	4
45	temperature of from 50 to 150°C to convert the sulphide sulphur into volatilize antimony chloride produced, and to convert the sulphide sulphur into	
	elemental sulphur;	
	(b) leaching the non gaseous product from 250 to 300 grams/litre of	
	80 to 100°C with an aqueous solution containing from 250 to 500 grant these sodium chloride to dissolve lead chloride and silver chloride, and to extract these sodium chloride to dissolve lead chloride and silver chloride, and to extract these	
50	chlorides from the remaining solids;	
	chlorides from the remaining solids; (c) cooling the sodium chloride leach solution from step (b) to about 20°C to precipitate substantially all of the lead chloride and separating the precipitated	
	lead chloride therefrom;	
	(A) fusing the lead chloride from step (c) and observed	
55	produce chlorine gas and lead;	
	(e) passing the chloride gas from the lead chloride-depleted leach solution	
	(f) recovering silver from the termining from step (c) by comentation with metallic iron; remaining from step (c) by weight of the silver and lead-depleted leach	
60	remaining from step (c) by cementation with metallic from,  (g) removing from 5 to 15% by weight of the silver and lead-depleted leach solution from step (f), and passing the remainder of the depleted leach solution to solution from step (h):	
	solution from step (1), and passing the formalized	
	(h) removing any lead and shver remaining in the	
	metal-depleted solution by iron cementation;  (i) precipitating zinc and other impurities from said removed portion of the	

		<u> </u>
	metal-depleted solution using sodium carbonate;  (j) part electrolysing sodium chloride in said removed portion of the metal-	·
	depleted solution to produce chlorine gas while leaving a weakened sodium chloride solution;	
5	(k) passing the chlorine gas from step (j) to step (a);	5
	(1) carbonating sodium hydroxide formed in step (i) to produce sodium	3
	carbonate and passing the sodium carbonate to step (i): and	
	(m) passing the remaining sodium chloride solution from step (j) to step (b).	
10	16. A process as claimed in claim 15, in which the concentrate includes arsenic sulphide and arsenic is volatilized in step (a).	40
10	17. A process for recovering metals from an ore containing lead, silver, and	10
	zinc sulphides, the process comprising chlorinating the sulphide ore to produce the	
	calorides of the metals and liberate elemental sulphur leaching the chlorides with	
	sodium chloride to remove lead and silver chlorides, separating lead chloride from	
15	silver chloride by cooling the leach solution, recovering silver by cementation of	15
	the lead chloride-depleted solution, reducing the concentration of zinc and other	
	impurities in a portion of the lead and silver-depleted leach solution, and passing both the zinc-depleted and non zinc-depleted portions of the lead and silver	
	depleted leach solution to the leaching step.	
20	18. A process for recovering metals from a sulphide ore containing at least the	20
	sulphides of lead, silver, and zinc, the process comprising converting the sulphides	
	into chlorides by chlorination, leaching the chlorides into sodium chloride	
	solution, removing lead chloride from the leach solution by crystallization for the	
25	recovery of lead, recovering silver from the leach solution by cementation, removing zinc from a portion of the resulting lead and silver-depleted solution as	25
25	zinc carbonate, returning the untreated portion of the lead and silver-depleted	25
	solution to the leaching step, electrolysing the zinc-depleted solution containing	
	sodium chloride to produce chlorine, the chlorination step being effected using	
••	ury chiorine gas to convert the metal sulphides to chlorides and sulphide sulphur	
30	to elemental suiphur.	30
	19. A process as claimed in claim 18, in which zinc is removed from a portion of the lead and silver depleted solution and the resulting process.	
	of the lead and silver-depleted solution, and the resulting portion is added to the leaching solution in the leaching step.	
	20. A process as claimed in claim 19, in which the said portion is electrolysed	
35	after removal of zinc therefrom to produce chloring gas, which is passed to the dry	35
	chornation step.	
	21. A process as claimed in claim 20, in which sodium carbonate is added to	
	procepitate the zine as zine carbonate, sodium hydroxide produced in the	
40	electrolysis is carbonated to produce sodium carbonate and the sodium carbonate produced is passed to the zinc carbonate precipitation step.	40
-	22. A process as claimed in claim 1, substantially as herein described.	40
	23. A process for recovering metals from an ore containing lead silver and	
	Zinc sulpnides, the process being substantially as herein described with reference	
AE	to the accompanying drawing.	
45	24. Lead, silver or zinc values when recovered by a process as claimed in any of the preceding claims.	45
	proceding similar.	

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1 SHEET

This drawing is a reproduction of the Original on a reduced scale

